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EMERGENT EVOLUTION AND HYBRIDISM

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THE essential supposition of emergence, or emergent evolution, appears to be that the product derived from the synthesis of any number of elements is often quantitatively and qualitatively supervenient over their mere sum, or resultant, and thus it becomes something chiefly novel, the important features of which may even be extraordinarily dissimilar from those of the elements and subgroups that entered into its composition. The laws relating to and governing the whole are therefore comparably as restricted and peculiar to it as the laws relating to and controlling the respective components are exclusive and limited to them, and those of the one may not be even adumbrative of the others.

It has been long recognized that familiarity with the attributes of elements does not confer the ability to prognosticate the qualities of the wholes resulting from their syntheses. The behavior of neither hydrogen nor oxygen gives the slightest suggestion of the properties of water. The possibilities of gunpowder may not be deduced by an examination of the properties of either charcoal, sulphur or saltpeter, or of a combination of any two of them. Carbon, hydrogen and oxygen, each examined with respect to its qualities, or any two together, afford no connotation of the characteristics of ethyl alcohol, if these elements be combined in the one way, or of the ether they make when there is another arrangement of them.

The behavior of molecules may not be ascertained through a knowledge of merely the properties of their separate constitutive atoms; the molecular compounds do not present attributes which by simple additions result in the properties of cells; many of the properties of individual animals and plants are vastly different from the sums of the properties of the respective cells of which they are composed, and the qualities and appurtenances of plant, animal and

human societies are far from representing nothing but the sums or mosaics of the characteristics of their several individual and subgroup constituencies.

This "novelty of behavior" has been well defined and interestingly discussed by a number of writers, and variously named "heteropathic causation," "emergency," "creative synthesis," "emergent vitalism," "organicism," "holism" and "emergent evolution." The term *emergent evolution,* suggested by C. L. Morgan, has been adopted by W. M. Wheeler, whose recent book treats the subject with serviceable succinctness and lucidity. Several others, including Wundt, G. H. Parker, Spaulding, Alexander and Smuts, have approved and elaborated the proposition, in one way or another, and Jennings has waxed enthusiastic to the point of declaring that "the doctrine of emergent evolution is the Declaration of Independence for biological science."

It is not inferred from the writings reviewed, Smuts possibly excepted, that the entire problem of evolution has been or may possibly be solved through the application of the principles of emergence. However, if nothing more, the hypothesis suggests a somewhat novel and interesting means of viewing the phenomena of a considerable section of the universe, including protoplasm, mind, personality and societies.

In an editorial[1] H. H. Laughlin stated that "geneticists, including students of eugenics, are deeply concerned with the facts of emergent evolution," and he also extended the idea to cover the phenomena observed in connection with qualities which seem to emerge from complexes of characters in organisms and particularly in man. He further suggested that some mutations may be of this nature. So far as I have been able to ascertain, Dr. Laughlin, in these suggestions, was the first to recognize the apparently pertinent coincidence between the supposition of emergent evolution, as outlined, and the apprehension of hybridism, or hybridity, as elaborated by Darwin and earlier observers, and especially by G. H. Shull, East, Hayes, Jones, Riddle, Jeffrey, Lotsy, Peacock, Harrison and other recent writers.

The term hybridism, or hybridity, as commonly employed by scientific plant and animal breeders, appears to signify a heterogeneous (we now know not necessarily heterozygous) condition of an organism with respect to two or more genes responsible for characteristics of discernible discreteness, whether they are linked to the extent of allowing crossing over, are allelomorphs or are distributed among two or more linkage groups. All these conditions usually prevail, wherein an organism may be heterozygous for certain genes and homozygous for others, all in one linkage group or distributed among two or more pairs of chromosomes. In this way bisexual plants and animals are commonly, to a less or greater degree, compositely hybrid in respect to a few, or several, characteristics for each of which they may be homozygous, and they would thus constitute true-breeding hybrids. In addition, they are generally heterozygous for several, or many other, factors with respect to which, of course, they do not breed true.

There are probably also genes that do not manifest themselves in the form of discrete characteristics even when contained in homozygous doses, yet they may become apparent as hybrid emergents when two or more different ones are represented in organisms in double doses, respectively, or some single and others homozygous. It is altogether likely that certain transient, apparently non-Mendelizing variations, or even some that remain constant as if they were outright mutants, belong to some such category. Several genes which modify recognizable characteristics, but which, of themselves, do not become manifest, have been reported. It is unlikely that any characteristic is ever the manifestation of the actions merely of one, or even two genes, or factors; each discrete characteristic is generally, if not always, the supervenient emergent of the interactions of several, or many genes. There are also other possibilities for heterogeneity, or hybridity of traits in bisexually reproducing organisms.

Darwin appears to have been the first to observe that it was the bringing together of dissimilar germinal substances, rather than the mere act of crossing, which produced extra size and vigor in hybrid plants and animals. Following his lead and in the light of Mendel's discovery and utilizing the results of their own and other extensive experimentation, G. H. Shull, East, Hayes and Jones have defined in some detail the probably precise means by which the changes, including additional size and vigor, as well as negative qualities, are obtained through hybridization. The hybrid vigor and increased size, as well as other superveniences derived from the crossing of different strains of Indian corn were emergents, each in respect to its properties, quite distinct from, and more than (rarely less than), the mere sum of the properties of the respective long inbred varieties. Numerous critically experimental results which support this thesis have been described by the authors named and by investigators who utilized for experimental purposes other plants and also animals.

More than three thousand named varieties of dahlias of widely differing color combinations, size and form have been noted by Jones, who states that all have been derived through hybridization from very

[1] *Eug. News,* January, 1929.

few elementary strains, with possibly a few mutants which occurred during the relatively short period of their development. It appears that most horticultural achievements have been attained by means of hybridization, either through man's intentional effort or by chance in nature. It is generally recognized that in all the higher and many lower forms of plants hybridization has performed a conspicuous part in the development of the limitless varieties found distributed among the almost infinite kinds of environment in which they live. Every important group, as cotton, wheat, corn, sorghum, all fruits, shrubs, trees, weeds, wild as well as cultivated flowers, and vegetables—all are well known to be largely and, in many cases, wholly of hybrid origin. In most of them the distinguishing characteristics of the contributive races have become largely dissembled by the respective hybrid emergences.

Starting with Darwin again, although the matter greatly antecedes his time, hybridization among animals, both the wild and domesticated, and including man, has been considered of major consequence. There is a vast literature dealing with the complexly hybridized condition of such domesticated animals as the fowls, cattle, sheep, dogs, cats and swine; in fact, all are involved usually to a high degree of heterogeneity, with infinite and incalculable numbers and varieties of supervenient emergences and probably with profound consequences in respect to distribution, tolerance and survival.

Among wild animals, hybrids are usually in such composite profusion, and so little do their hybrid emergent properties and the attributes of their constitutive elements adumbrate each the other, that it becomes quite impossible casually to distinguish them. Adequate analyses are feasible only if the organisms carry sharply contrasting characteristics and lend themselves to being bred in comparatively large numbers and over considerable periods of time. Among the more intricately complex, particularly the larger, slower-breeding, domesticated animals and man, rapid and commensurate analyses seem to be as yet impracticable, perhaps more because of the long time and excessive expense involved than on account of their complicated genetical natures.

The most extensive, critically experimental hybridization project of all time has been that of T. H. Morgan, his immediate colleagues and other workers throughout the world, in which the fruit-fly (Drosophila) has been utilized. Following Bateson's analogy and considering the genes responsible for the various characteristics as elements, the methods employed and the results obtained are closely coincident with those in chemical resolution and synthesis. The four hundred, or so, mutant genes of the fruit-fly have been allocated in a system such that they may be used in breeding synthesis and analysis in the identical quantitative way in which the chemical elements are employed. Other projects of this nature, contributing evidence in support of this generalization, all in the field of hybridism, have employed as experimental materials corn, tobacco, jimson-weeds, evening primroses, grouse locusts, mice, rats, guinea-pigs, rabbits, birds, fowls and, to some extent, the larger domesticated mammals and man, and a number of other organisms.

The methods, results and possibilities of genetics (experiments in hybridity) may be further illustrated by referring to the grouse locusts (Tettigidae) with which I have worked for several years. This subfamily of the Orthoptera has extraordinarily striking and variable color patterns. In one species (*Paratettix texanus*) a few over twenty-five distinct, dominant, elementary patterns have been resolved in the breeding processes. Twenty-two are so closely linked as not to allow crossing over; one is rather loosely linked with these, and one each appears to be on two other pairs of chromosomes. However, even with this arrangement, a prodigious number, mounting into the hundreds, of color pattern combinations have been developed. Many of these hybrid emergent patterns are stable, when inbred, while others are relatively so. In another species (*Apotettix eurycephalus*), in which linkage is not so close, other hundreds of true-breeding as well as unstable composites may be and have been developed from the thirteen conspicuous, diagram-like, dominant, primary color patterns.

Reference to the colored plates of my publications, or better, a view of the specimens in nature and in the laboratory, reveals the extraordinary extent of variations in color complexes, all derived from comparatively few primary patterns. Before experimental resolution and synthesis had shown how few original, primary characteristics were involved in the production of these numerous color pattern composites, speculation regarding them had been rife. The dominant, elementary color patterns, as well as the hybrids of the grouse locusts, are peculiarly discrete and diagram-like. They ought to lend themselves, the one to decipher the others, perhaps better than the characteristics of almost any of the other organisms hitherto submitted to Mendelian experimentation; yet in only exceptional cases, without previous experience, would it be possible to predict, merely upon inspection, what a specified group of elements would make, or what had gone into the production of a given complex. Now, with experience, numerous composites, each a supervenient emergent as novel in its attributes as any of the several components, may be

developed at will. If the mutants which certainly occur, though rarely in the grouse locusts, be included, the probability of increased numbers and variability of hybrid emergents would be proportionately enormously enhanced.

The work with the grouse locusts so far has been devoted mainly to syntheses and analyses of color patterns and combinations. However, it has also been determined that certain size, form and vigor properties, some negative and others positive, including the capability of reproducing parthenogenetically and to simulate death, are emergents of hybrid syntheses.

So, altogether, there have been employed a considerable number of color, form and vigor, primary characteristics, ranging from very brilliant to extremely dull, and from strongly vigorous to lethal, not to consider those too subtle to be easily recorded. All are readily capable of hybridizing in practically infinite variety, and there have, or may, come into existence supervenient hybrid emergents almost limitless in number. Paraphrasing a passage from C. L. Morgan, it is beyond the wit of man to number the instances of emergence, even among the grouse locusts.

In a considerable number of hybrids, to be sure, especially among the higher animals and man, some of the respective characteristics may be blended or arranged in mosaics in such manner as to indicate certain of the qualities of the component races. Even so, such composites generally exhibit, in addition, qualities extraneous to any shown by the original organisms, and at the same time some of the properties of the latter are lost in the process. In this category probably belongs the mulatto, many of whose qualities, in spite of certain degrees of blending, are superveniently different from the mere sum or mosaic of the several characteristics of the white and black races. The respective properties of the ass and the horse would not, by simple addition, or mosaically, make a mule, and the cattalo is far from displaying nothing but the sum or mosaics of the several attributes of buffalo and cattle. Nearly all the higher plants and animals when hybridized—and which are not?—exhibit extraneous qualities such that they largely, or completely effect the dissimilitude of the qualities of their several, contributive, primary races. The list of specified cases could be extended to great length and still remain within the bounds of quite familiar plants and animals. If, on first consideration, the appositeness of some of these illustrations comes into question, it is simply because of our familiarity with the production of such common hybrids. If they were coming into our knowledge for the first time, or if we should approximate precision in estimating their several qualities and appurtenances, as compared with those of the races that go into their making, the novelty of their emergent properties would be quite marked and bewildering.

The tendency to assume that hybrids represent nothing but the sum or mosaics of the characteristics of the races from which they may have been derived has led to numerous signal failures of efforts at producing desirable hybrid composites. Many statements and inferences of plant and animal husbandmen, anthropologists, sociologists and writers in general have brought me to this conclusion. The outlines of several state and federal (U. S. A.) experimental projects, with the expenditure of considerable effort and funds, have been based on this assumption. Familiar examples have been those proposing to develop double-purpose cattle and fowls by hybridizing large beef- with high milk-producing cattle, and high egg-laying with big meat chickens, respectively. The converse of this process have been the efforts, some in the field but mainly in museums, to determine by examination of their characteristics just what had been the original contributive races of various groups of plants, animals and man. It is almost needless to add that the results from most such enterprises have been radically different from those expected and generally disappointing. Even when gains did accrue they were not those aimed at. In general, without previous experience, hybrid emergents may be no better prognosticated than the emergent products of the first syntheses of chemical elements. It even appears to have been a common experience that positive or useful properties were quite likely to emerge from the hybridization of negative or useless characteristics, and *vice versa.*

During the past thirty years the principles of heredity have come to be quite well understood. However, the possibilities of application of these principles in human affairs remain largely to be realized. As noted above, we have not even passed the contingency of developing a strictly scientific technique for the production of valuable hybrid varieties. The uncalculating, extensive methods of hybridization employed by the Burbanks of all time, to such an extent appropriately deplored by scientists, yet in practical results quite successful, may even in this advanced day still remain the irreducible expediency. Since we thus far probably have nothing better in technique to propose, our animadversions might very well be limited to censuring them for failure adequately to record the kinds of crossings and the resulting frustrations and successes. Among the most manifest and importunate requisites of practical biology to-day are great, adequately supported, continuous and perspicaciously conducted projects in hybridization among the respective varieties of the higher animals and plants. The prospects are that progress would

be closely analogous with that of chemistry. However, the knowledge of heredity and the casual accomplishments in hybridity already realized would probably make attainments considerably more rapid.

Mutations (neo-Darwinian variations) range from the ordinarily imperceptible, though possibly quite potential under circumstances of hybridism, to those of considerable magnitude. They are of multifarious, chance kinds and utterly without objective. Each new mutant gene in practically any group of higher plants or animals proportionately greatly augments the probabilities of supervenient hybrid emergents. These, in turn, are as much fortuitous sorts and without direction, or objective, as the mutants themselves.

Wheeler states "that there is not on the planet a single animal or plant that does not live as a member of some biocenose." It is likewise probably true that there is no single bisexually reproducing animal or plant which is not in some essential features a supervenient emergent of hybrid syntheses. Hybridity has probably been the efficient, ultimate agency by which the mutant characteristics of all varieties and races of bisexually reproducing organisms, including man, have attained whatever casual, eventual grade of supervenient emergency they may have severally occupied, whether they were among the preponderant legions below the point of ability to survive, those in the situation of being merely tolerated, or the comparatively small numbers which appear to have been reasonably well adjusted.

Natural selection creates nothing; it is strange that anybody ever misunderstood or misstated Darwin to the effect that it does. Mutations and hybridity furnish the materials, mainly, perhaps among the higher organisms wholly, in the form of supervenient individual hybrid and biocenose emergences of fortuitous kinds and without objectivity or direction. The vast majority perish, some linger awhile, others are suffered, while presumably relatively few are fairly well adapted to the dynamic, intra- and interpermeating complexes of the environment; which encompassing complexes are, in turn and in their aspects, as much supervenient emergences as are the intra- and interpenetrating organisms and societies they environ. Here, then, are the exclusive field and materials in and on which it is considered that natural selection operates.

We are probably not yet in the position, certainly it is not intended in this paper, to estimate the share, if any, that should be allotted to hybrid emergence as here defined, in the consideration of the causes of evolution. Bateson's challenge apparently still stands unanswered, at least experimentally; no one has yet demonstrated, either through hybridism or by any other means, a method by which progeny may be derived which are fertile among themselves yet which do not produce fertile offspring when mated back to the original stock.

We are still in a morass, it may as well be admitted, with regard to the ultimate problems of evolution. However, de Vriesian mutations (neo-Darwinian variations)—possibly irradiation-induced mutations, hybrid emergence (emergent evolution) and natural selection constitute features of a rough path, a sort of crude track through the jungle, beaten by Darwin's seven-league boots, that may soon open into somewhat of an upland clearing from which a further reconnaissance may be made.

BIBLIOCHRESIS: THE PILOT OF RESEARCH

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Whereby the sedulous worker
His laboratory course does steer.

BIBLIOCHRESIS, the scientific use of literature, has the pilotage of all scientific investigation. It has, in fact, the same relation to research as the latter has to management; it is the intelligence service of all orderly inquiry, the preparational agent of factual determination, the guide of experimental trial in eliminating chance, in the whole realm of science.

To be scientific, an investigation of any type must be made methodically—a condition that requires, primarily, that all scientific research be conducted in the light of recorded experience. This requirement applies to the exercise of the historical and analytic procedures of investigation as well as to the employment of the experimental method, whose use, whether for confirmation or for original work, rests upon prior knowledge and art, *i.e.*, accepted practice.

Bibliochresis, then, is the most indispensable tool in laying the foundation for scientific research. Since it enables the qualified worker to find the experience of his predecessors, as recorded in the literature, it confers upon him either the power to predict the results of effort—this is the outcome if the recorded information is evidently factual, *i.e.*, definite and confirmed—or the ability to plan further research on the same or an analogous topic. Reference is had throughout this communication to the proper use of the results of bibliochretic study and not to the incor-

rect employment thereof in the place of indicated experimental investigation. Bibliochresis is never a substitute for needed laboratory research.

The collection of recorded experience—the function of bibliochresis—is plainly the provision of data for facilitating scientific decision and for projecting research. The factual information thus acquired is the groundwork for the comparison and measurement that compose analytic research; it is also the foundation for gaining the new ideas that characterize invention and discovery. Continued progress in science became possible only when the development of the art of printing enabled investigators to make use of the recorded observations of other scientists.

The necessity for a literature search as a prelude to experimental investigation, either disinterested or industrial, has long been an axiom of the scientific professions. The importance of this first step has often been stressed, but rather as a policy of pedagogical value than as a defense of the procedure. Laments at the increasing volume of scientific literature have become hackneyed, demands for more efficient abstracts and reviews have become strident, but these various voices have not been raised against the value of an intimate knowledge of previous researches in a given field.

The wastefulness of needless repetition of experiments already described in the literature and the concomitant inefficiency that allows pertinent experimental findings to remain buried in the library were deplored in a recent editorial in *Nature*.[1] The *Engineering and Mining Journal*,[2] aroused by this article, questioned vigorously the advantages of a literature search as a preliminary to experimental investigation, particularly when a novel technical achievement is the goal. *Metals and Alloys*,[3] a welcome new periodical, has no less firmly taken its stand beside *Nature*.

Of the men best qualified to analyze the factors that lead to high scientific attainment—research directors, personnel managers, experienced investigators, technical editors, educationists—few will deny the necessity of library studies as a discipline for the self-conceit of the researchful mind. The scientific societies and organizations and the philanthropic agencies for the advancement of science have been unanimous in recommending increased use of existing facilities and concerted effort to improve the technical libraries throughout the world. Very recently an officer of the National Research Council has expressed the view that there should be a good working library of science in each educational and industrial center. Such a library would require an initial outlay of at least thirty thousand dollars and a minimal annual expenditure of one thousand dollars thereafter.

The opinion of these authorities concerning the value of bibliochretic work and opportunities is confirmed by several facts.

(1) Bibliochresis occupies a prominent place in the curricula of research training schools. For example, a number of universities are now giving courses in chemical bibliography. Among the text-books dealing with the subject wholly or in part should be mentioned "The Literature of Chemistry," by Crane and Patterson; "Chemical Publications," by Mellon, and "Introduction to Organic Research," by Reid. "Medical bibliography" is another pedagogic innovation.

(2) There is a constantly increasing demand in industrial laboratories for chemical bibliographers, other scientific literary specialists and chemical economists.

(3) The recognition of the need for bibliographic material in compact form is shown by the demand for indexes to the literature, as evidenced by the large number of orders received by their publishers.

(4) Satisfactory incomes, considering everything, are enjoyed by a number of practicing bibliographers who specialize in preparing, for stipulated fees, select bibliographies and also reviews of the journal and patent literature.

(5) Many men have been found to be unsatisfactory in industrial research because of their lack of knowledge of elementary bibliochretic procedure. How often in our personnel work we have seen the criticism of a referee of a candidate to the effect that the latter "was not able to work with ease and interest in literature searches" or "was replaced by a better man because he could not be depended on to make a thorough survey of the literature."

(6) Systematic bibliochresis is the means of establishing authority and originality, in science as well as in history and jurisprudence.

In discussing the subject of bibliographic studies from a broad point of view, several varying requirements must be taken into consideration. The type of literature survey best suited to any given problem must be decided, of course, in each particular case. There is, so to speak, a law of diminishing returns for library work. The handbooks, monographs and other reference manuals give a maximum of information in a minimum of time. When the search is projected into the original literature, the information to be obtained tends to become more and more diffuse as the quest is made more thorough. "Bibliography is as complicated as anatomy, as intricate as physics, as certain as history and as interesting as life itself," is the view of a great medical educationist.

[1] *Nature*, 122: 913, 1928.
[2] *Eng. Min. J.*, 128: 383, 1929.
[3] *Metals and Alloys*, 1: 197, 1929.

Bibliochretic lists and indexes are often prepared by general agencies for the promotion and encouragement of research. All administration of the proper type must rest on factual information, and hence any methods that facilitate the location of facts are short-cuts to sound management. In providing these indexes, which are of great value as starting-points for bibliochretic studies, such organizations are performing an important service, particularly because it is becoming increasingly difficult to arrange for the publication of material of this kind through the scientific press.

Among the most valuable bibliographies, or classified reference lists of literature, should be mentioned those of C. J. West, of the National Research Council. His "Bibliography of Bibliographies on Chemistry and Chemical Technology," prepared in collaboration with D. D. Berolzheimer, and "Bibliography of Pulp and Paper-Making" are examples of some of the important contributions he has made to the classification of ultimate sources of knowledge. E. H. McClelland, head of the technology department of the Carnegie Library of Pittsburgh, has produced several bibliographies, especially in the realms of ferrous metallurgy and fuel economy, that are classical in their accurate scope. At one time the Smithsonian Institution subsidized the publication of quite a few bibliographies; in chemistry the original aim was to index all the books and periodicals and also the special literature of the elements and of certain important compounds.

Noteworthy examples of bibliochretic studies, or critical indexes of the literature, as they might be termed, are found among the monographs sponsored by various technical organizations, such as those of the American Chemical Society. These books give not only comprehensive lists of references to the original literature, but the author in each case, usually a dean of the investigators in his field, unifies and summarizes impartially the experimental contributions that have been made. The constantly increasing cost of publication and the lack of space due to this factor as well as to the large number of papers that come before almost every editor for consideration have led to the existing preference for select bibliographies. These condensed indexes also save the time and serve the needs of the average reader.

There is considerable difference in many cases between the character of the library work appropriate for academic and that for industrial research. In the field of pure science, searching literature studies are made more or less as a matter of course. Such work is for the most part carried out in universities or research institutes with good bibliographic facilities and with somewhat more deliberate an atmosphere than that in an industrial laboratory. There is usually a professor or research director to plan the investigation, which is generally for a thesis. The problem selected must be reasonably free from overlapping studies in order that the junior author may be assured of a research publication; he is supposed to publish a paper to fulfil all the requirements for his degree, or, at least, he is eager to be able to treasure reprints of an addition to his short list of papers. In either case, the disappointments aroused by finding that his efforts have been dissipated on something already worked out is not to be taken lightly by those who are training our youth for enthusiastic scientific careers. Then, too, his own efforts to make use of the library are not to be overlooked. An exhaustive bibliography is an essential part of his thesis (and it is to be regretted that more theses, with their extended bibliographic studies, are not available for general use). In his conversations with fellow students he incites them to destroy the historical background of his work. Finally, when the completed article is submitted to a journal, a board of editors jealously guard against the duplication of a previous publication. It must be remembered also that the literature pertinent to a problem in pure science is likely to be more easily located than in the case of an industrial project. In spite of all these precautions, unwitting duplication of results is not unknown.

The bibliographic problems of the industrial research man are much more complicated. He is expected to use his time to the best advantage. He must work in libraries that, as a rule, are not so thoroughly stocked as those of the universities, although this condition is being improved markedly. The literature of industrial science is more difficult to follow: the journals for both the technical and pure science publications must be examined; the patent literature must be much more carefully searched than in the case of pure science research; the publications of most interest to him will often contain veiled meanings, and finally, the things for which he is searching may have been done but never published. This last possibility is of the greatest importance in connection with supposedly patentable processes and products.

There are, it is true, some scientists in both pure and applied research who have been eminently successful in spite of the fact that they have purposely refrained from systematic use of the existing literature. They are usually of the genius type, men of great originality and resourcefulness, who would have achieved fame in any field. A noted scientist comes to mind—a heroic figure, inspired, intrepid, a veritable lion of research, yet withal a kindly philosopher

whose personal charms have endeared him to two generations of students. His views are that a methodical, mechanical bibliochretic survey cramps his imagination, that it often turns him from profitable paths of research, that he has never been able to duplicate exactly any one's results and, finally, that to him the never-ending joy in scientific work is in finding something he did not know before, even though it might have been found previously by many other workers. Few of us can attain to his heights. As time goes on and the various fields become more and more thoroughly worked over, genius will find it increasingly difficult to assert itself.

It seems to us that the attitude of mind of the man who can achieve continuous research success without using the literature systematically is susceptible to further analysis. He has a profound knowledge of his specialty and he keeps in touch with current progress, although in a desultory fashion. His self-confidence is maintained by his achievements as well as by his grasp of the field. He can therefore plan new work by visualization with reasonable accuracy. Self-satisfaction with his procedure comes to him through his success.

All of us sympathize with this attitude, but it is more than questionable whether it should be encouraged as a matter of general practice. The position of the scientist in the world has changed; he is no longer an unimportant person following the vagaries of researchful imagination, but an important factor in the economic life of a country. Neither industrial laboratories nor research institutions would subscribe to the view that a scientist has fulfilled his duty if he gratifies his personal curiosity by rediscovering old facts merely because he has been too unsystematic to search the literature.

An aspect of bibliochresis seldom emphasized is that, in the hands of a specialist endowed with imagination, trends in research can be analyzed and forecasts can be made with a reasonable degree of probability. The worker can avoid fields in which, from a survey of the literature, it appears that too many groups of workers are engaged to give promise of marked success if he starts in, far behind, to catch up with the others. On the other hand, a particularly keen man can sometimes perceive an important goal which the mass of workers have been too preoccupied to see.

The scientist, scorner of riches though he may be, almost invariably has a certain respect for the acumen and enterprise of the successful business man. The world of affairs, on the other hand, although somewhat awed by the researcher, usually regards him as impractical. It is somewhat paradoxical that the great strides made in business practices during the present generation are in large measure due to the introduction of the scientific method into managemental procedure. Library research has played an important part in all such changes.

Nor has scientific management been neglected by the industries based on science. Before the war there were few persons who could qualify, for example, as chemical economists, but in this respect other fields of management were no further advanced. Now we find in every branch of industry economic surveys of unsurpassed excellence, and the technique of collecting and analyzing such important data is advancing continuously.

Organization is characteristic of the age. All human activities are becoming more and more a matter of coordinated regulation. The dietetically chosen food we buy on a budget plan from a chain store has been systematically approved by city, state and national health officers; it has been distributed, with or without intermediaries, to the retailer according to his calculated sales volume by the manufacturer, who has prepared its reception by scientifically executed advertising; it has been transported over railroads whose interrelations are controlled by governmental regulation based on economic reasoning; the raw materials were selected by means of standardized tests; even the ultimate producers are now being more and more firmly knit together by the economic necessity for management on scientific principles.

The same spirit of organization hovers over the research laboratory, which creates such products. The haphazard methods of the inventor will experience increasing difficulty in competing with organized research, both in pure and applied science. As the literature increases, more and more critical studies will be required, and still larger research units will be obliged to correlate their efforts to avoid duplication. It is not the time to urge less use of the library, but to encourage research workers to follow the literature as never before.

OBITUARY

STEPHEN ALFRED FORBES—A TRIBUTE

ON March 13 Professor Stephen Alfred Forbes passed away at Urbana, Illinois, after a brief illness. His end was no doubt hastened by the death of his wife, which occurred on January 24. Despite his eighty-six years, Dr. Forbes was active until within a few days of the end and at the time was the oldest servant of the state of Illinois, which he had served

in varied capacities for some sixty years. In his lifetime he had done distinguished work as a soldier, teacher, administrator and researcher such as to command recognition not only at home but also in scientific circles in this country and abroad as well.

Stephen Alfred Forbes was born on a farm in Stevenson County, Illinois, on May 29, 1844. He was of Scottish ancestry, his forbears having come to America before 1660 and his greatgrandfather having been a soldier in the Revolutionary War. When the Civil War broke out he, then a lad of seventeen, enlisted in September, 1861, in the Seventh Illinois Cavalry as a private and was promoted rapidly until made a captain at twenty years of age. While carrying dispatches in 1862 he was captured and spent four months in prison. After a three months' hospital term recuperating from the illness acquired in prison he rejoined his command and served to the end of the war. It was a source of great delight to hear the story of those days when on rare occasions he could be persuaded to relate to younger friends some of his experiences in the field.

Dr. Forbes's interest in nature was no doubt innate but was stimulated in early life by the contact with woods and wild life along Silver Creek, a beautiful stream near his home. The opportunity for formal education was not given there at that time, and the death of his father when he was only ten years old threw added difficulties in his way so that he enjoyed but a brief period of study at Beloit Academy. However, in his early years he was enamored of languages, and by private study he had learned to read French, Spanish and Italian before the war broke out. He took up the study of Greek while in prison.

At the close of the war his mind turned at once to education and he entered immediately on study at Rush Medical College, where he almost completed the course in medicine. But a change of plans led him to teach school in southern Illinois. His own studies in natural history ardently pursued at the same time led in 1870 to the publication of his first scientific articles in the *American Entomologist and Botanist*.

Through the attention attracted by these articles Forbes was named in 1872 curator of the Museum of the State Natural History Society at Normal, Illinois, the seat of the then most prominent educational institution in the state. Three years later he was appointed instructor in zoology at the normal school. In 1877, when the present State Museum was established at Springfield, the Normal Museum, which had become the property of the state, was made the Illinois State Laboratory of Natural History, and Forbes was appointed its director. In 1884 he was called to Urbana as head of the department of zoology and entomology in the young and rapidly developing state university. The State Laboratory of Natural History was transferred by legislative enactment to the University of Illinois, and he remained director until in 1917, with a revision of the state code, it became the Illinois Natural History Survey and he was appointed its chief. This position he held at the time of his death. He was also state entomologist from 1882 to 1917, when the position was merged in the survey. Under his hands the work grew in volume and power until at present it has a staff of fourteen permanent workers and numerous other helpers.

Though carrying large extra time-consuming responsibilities in these state positions he discharged educational duties in the university of major importance. From 1884 to 1909 he was in charge of both entomology and zoology, and after that head of the department of entomology alone until his retirement as emeritus professor in 1921. He served also as dean of the College of Science from 1888 to 1905, and until his retirement was retained by the university senate as chairman of the important committee on university educational policy. He brought about the introduction of natural history into Illinois schools and of laboratory study in its secondary school curriculum.

Despite these heavy official duties, he found time to answer special calls for public service in other directions. At the time of the Chicago Exposition in 1893 he prepared an extensive exhibit of the natural history of Illinois, he served as director of the aquarium and exhibit of the U. S. Fish Commission, and as chairman organized the National Congress of Zoologists held in connection with the exposition. Locally, his influence was steadily exercised in behalf of significant movements. Chief among these ranks the establishment of the Champaign County Tuberculosis Sanatorium, a movement organized and despite serious obstacles carried to a successful outcome under his leadership. Only two years ago the Urbana Association of Commerce had presented him with a special testimonial "in recognition of long, faithful and brilliant public service."

It would be impossible to enumerate here all the civic and scientific organizations at home and abroad in which he held membership or those which had bestowed upon him honorary membership. He joined the American Association early, having been secretary of the section on zoology in 1883, and was also for many years a member and officer of the leading entomological societies. He was a charter member of the Illinois Academy of Science, which had already planned to pay him special honor at the coming meeting to be held in Urbana, May 2. The National Academy of Sciences and the American Philosophical Society had also elected him to membership. A more

recent honor was his selection in 1928 as an honorary member of the Fourth International Congress of Entomologists. Among academic honors may be recorded his election to Phi Beta Kappa and Sigma Xi.

Since retiring from active participation in the work of the university, Dr. Forbes has devoted his attention exclusively to the State Natural History Survey and has built up an organization which is widely recognized for its scientific work. The outstanding feature of the work of the survey has been a study of the biological resources of the state. While still teaching he directed an important series of theses on the fresh-water organisms to furnish a basis for the accurate determination of the forms present in Illinois. He himself contributed two magnificent volumes on the fishes of the state, as well as a host of other contributions in the form of reports and discussions of the fauna of Illinois rivers. In fact, his chief work was the elaboration of those relations between organisms and the environment which constitute the basis of the new and rapidly growing field of ecology. In cooperation with his assistants in the Natural History Survey, extensive studies were made of the aquatic organisms of the Illinois River and to him we owe an accurate picture of the changes produced in that stream by the construction of the Chicago drainage canal and the diversion of the current of the Chicago River into the basin of the Illinois River. Because of his work the Illinois River has been declared the best-known stream in the world.

The scientific work of Professor Forbes was diverse in character and conspicuous in all its varied aspects. His publications, which number more than five hundred, cover topics in entomology, ornithology, ichthyology, limnology, ecology and other phases of biology. In many directions he opened up new lines of work and nowhere did he handle his subject in mere routine fashion. The generally high character of his writing was early recognized, and in 1886 the Société d'Acclimatation de France awarded him its premier medal for his scientific publications. His series of eighteen entomological reports contains an immense volume of carefully amassed data regarding the insects of Illinois in their relation to the welfare of the state and includes also extensive studies on methods of combating their attacks which have served to protect the agricultural interests of the state and to profit its workers. While directly useful in a practical way, these reports have embraced also much work of high scientific value. He will always be looked upon as the first and the leading worker in America on aquatic biology. When he started on his studies of fresh-water organisms the inland waters of our country were practically unknown. He was the first man to write on the fauna of the Great Lakes, and to contribute to a knowledge of the food of fishes, a fundamental piece of work for the proper understanding of the factors concerned in solving questions that are involved in the preservation of our commercial fisheries.

Starting at an early date with studies on the food of birds, Dr. Forbes conducted for many years observations on the bird life of Illinois, so well planned and executed that the survey has given an accurate conception not merely of the species occurring in the state, but also of their frequency and exact distribution, which together form a basis for a conception of their true value to agriculture and in the conservation of natural resources also.

The career of Dr. Forbes was unique in several ways. First of all he had enjoyed very little formal education. Unaided he gained command of languages to an extent very unusual in his day and age. He never received a bachelor's degree, and yet Indiana University, under the leadership of David Starr Jordan, granted him the Ph.D. degree on examination and the presentation of a thesis. While teaching he carried on studies in natural history, which were independently developed not merely in a single field but in several to an extent that made men speak of him as the first economic entomologist in America, as the leader in the study of aquatic biology and as the founder of the science of ecology. He was not only a pioneer in these and other fields, but one whose pioneer work laid out intuitively the roads to be followed in future cultivation of those fields. Finally, it was no chance matter that though a pioneer in many new fields he never dropped back as the field opened up and the workers became many. He was always at work and his mind was strong enough and clear enough to grow *pari passu* with the growth of the field, so that in later days he still led the workers engaged there. He maintained his alertness and mental vigor to the last.

In all his writings he manifested a beauty of style that made them unusually appealing, an accuracy of statement that gave them reliability and a keenness of analysis that stimulated the reader and student to mark out his own research along productive lines. He ranks not only as the greatest of Illinois naturalists, but among the few leading students of natural history which our country has produced.

Personally, Dr. Forbes was a man six feet in height, of powerful build, and he walked with a firm military bearing. His speech was quiet and unassuming, his voice clear and pleasant. Before an audience he appeared at ease, and without effort spoke with power enough to reach and hold the largest group in interested attention. While an indefatigable worker, he still had many general interests in life and

found time to be the president of the first golf club organized at the university. Later in life driving an automobile was his favorite pastime, and he often chuckled at a comment on his arrest for speeding on his eightieth birthday. He was married in 1873 to Clara Shaw Gaston, whose death only a few weeks ago was a heavy blow to him. His son, Dr. E. B. Forbes, of State College, Pennsylvania, has already achieved distinction in science. Three daughters also survive, Mrs. B. R. Herring, of Chicago; Mrs. F. W. Scott, of Boston, and Miss Winifred Forbes, of Berkeley, California.

HENRY B. WARD

UNIVERSITY OF ILLINOIS

SCIENTIFIC EVENTS

THE UNIVERSITY FILM FOUNDATION OF HARVARD UNIVERSITY

THERE has been established at Cambridge a University Film Foundation, by the aid of a gift made last fall by Mr. John D. Rockefeller, Jr. The foundation is able to make completely both silent and talking films in their plant. A sound-proof studio has been installed, and in connection with it a complete sound-on-film recording equipment, loaned to them by the R. C. A. Photophone. The studio could serve as a center for radio broadcasting, since the acoustic treatment it has received fits it for this purpose.

In addition, the foundation is installing a disc-recording machine which will be employed for transferring the sound-on-film to discs, so that the films will be available with both methods. This machine can be used for making phonograph records and records for broadcasting.

A well-equipped laboratory has been built for developing and printing the films, both standard-width and 16-millimeter size. Mr. Rockefeller's gift has also enabled the provision of more adequate working quarters, editorial rooms and offices for the staff.

During the past six months the foundation has nearly doubled its staff, which now numbers more than twenty persons. In addition to a personnel with college background, specially trained for production and editorial work, the foundation has specialists, such as a sound-engineer, projectionists and a laboratory man.

With this staff and equipment the foundation stands in a position where it can apply modern inventions and technical processes to educational methods. Already, with its previous limited facilities, the foundation has made a large number of educational films in a number of fields. By last September, after one year of existence, the foundation had released twenty reels of films in the fields of geography, biology, anthropology and the fine arts.

The foundation is about to start making a photographic record of eminent professors and personalities connected with the university. This is in line with their work on the Harvard Film, a general descriptive film of the university which they completed last year. That film was, however, silent, and the new films will be talking films. It is planned not only to record the professors' speaking, but also to show them illustrating their experiments and making demonstrations of scientific materials. A talking film on Massachusetts history, with Professor Albert Bushnell Hart depicting the development of the commonwealth, is now all but completed.

THE U. S. PUBLIC HEALTH SERVICE

A BILL for the reorganization of the U. S. Public Health Service has passed both houses of Congress and now goes to the President. Another bill has just been passed by the Senate, but has not yet been passed by the House, providing for the creation of a National Institute of Health, which would greatly expand the facilities for health work by the U. S. Public Health Service. A system of fellowships and provision for accepting donations for special work, such as research work on cancer, is a part of this National Health Institute plan.

Science Service reports that the Jones bill provides for putting the federal health service on a basis which will make it one of the best public health services in the world. There will be more regularly commissioned public health officers and a better chance for a young man in the service to look for promotion. A number of those now under the civil service would be given commissions. The bill aims to put all the public health work of the government departments under one coordinated management as well as to increase the number and kind of commissioned public health officers. Among the provisions of the bill are:

1. That whenever some branch of the government wishes to carry on a public health activity, the Secretary of the Treasury shall detail officers and employees from the Public Health Service to cooperate and direct the work.

2. Whenever special health problems should be studied and certain research or educational institutions have facilities for this study, the Surgeon-General may detail health officials and scientists from his staff to take up their quarters in such laboratories and work there.

3. Great expansion of the Hygienic Laboratory in the District of Columbia.

4. Great increases in personnel under certain conditions. A total of fifty-five officers to be appointed by the President—medical, dental, sanitary engineers, pharmacist officers—and shall be credited with service in the Public Health Service and active commissioned service in the Army and the Navy. All officers and employees other than the commissioned officers in the service shall be appointed under the civil service.

The new bill would put the Surgeon-General of the Public Health Service on a par financially with the Surgeon-General of the Army, increasing his pay to $9,700.

CHEMISTRY AT THE SUMMER QUARTER OF THE OHIO STATE UNIVERSITY

THE department of chemistry of The Ohio State University will offer a greatly enlarged opportunity for both graduate and undergraduate study during the summer quarter for 1930. The first term of the quarter will extend from June 16 to July 23, and the second from July 24 to August 29. A student may register for either term or for the entire quarter. All courses will be presented which are required of undergraduate students majoring in chemistry. Research work and most of the courses prerequisite to advanced degrees will be presented in the fields of analytical, inorganic, organic and physical chemistry.

The following members of the faculty will be in residence: Professors C. E. Boord (organic), W. E. Henderson (inorganic), H. L. Johnston (general and physical), Edward Mack (physical) and H. V. Moyer (analytical). In addition to these members of the regular staff, Professor Thomas Martin Lowry, professor of physical chemistry, University of Cambridge, England, and Professor Richard Allen Morton, University of Liverpool, will be visiting professors in the department.

Dr. Lowry's work in the fields of dynamic isomerism, valence and optical rotation is well known. He will offer a course on optical rotatory power (July 1 to July 23), and one on the physical basis (mainly spectroscopic) of chemical theory (second term). During the second term, Dr. Morton will also present a course on photo-chemistry, in which he will outline some of the newer advances in this field and at the same time he will discuss the recent work of E. C. C. Baly, of the University of Liverpool, which has resulted in the fabrication of certain sugars photosynthetically. In addition, Dr. Morton will present a series of lectures in certain advanced fields of organic chemistry.

Of interest to all graduate students will be courses in chemistry on "Conduction of Electricity through Gases" and "The Application of Thermodynamics to Chemical Phenomena," by Professor H. A. Wilson, of the Rice Institute, and on "Molecular Spectra," by Professor W. W. Watson, of Yale University.

All inquiries and communications with reference to the program should be sent to William Lloyd Evans, chairman of the department of chemistry, The Ohio State University, Columbus, Ohio.

ENGINEERING PAGEANT

DR. GEORGE PIERCE BAKER, of the department of drama of Yale University, wrote a pageant which was presented in the auditorium of Stevens Institute of Technology in Hoboken on the afternoon of April 5, as the main feature of the first day's celebration of the Fiftieth Anniversary of the American Society of Mechanical Engineers. It was in this auditorium that the organization meeting of the American Society of Mechanical Engineers was held on April 7, 1880.

This pageant of the progress of engineering was divided into three parts, entitled "The Beginnings," the "Age of Steam" and the "Age of Electricity." Momentary darkness was followed by motion pictures showing great open stretches of land and sky, and then the natural elements—wind, water, lightning, steam from craters. Neanderthal man, seeing the great forces, is awed. Need creates desire. Curiosity stirs imagination. These give rise to simple invention by which man slightly controls a force in nature. Here is shown the making of the first tools. At the end appears "Control," a child, who uses the words of Carlyle: "Man is a tool-using animal, weak in himself and of small stature, feeblest of bipeds! Without tools he is nothing, with tools he is all." The figure of "Control" develops from a child to a powerful man.

The second part, the Age of Steam, showed the emergence of the mechanical engineer, and centers about Watt and his invention and improvement of the steam engine. The third part introduced the Age of Electricity. This section center around Faraday and Edison. Next come the great inventions since 1880, showing the stages from the earliest to the most modern automobiles, the modest house and today's skyscraper, the steam engine of 1880 and the most recent locomotives, the turbine and the great steamships, wireless telegraphy, the airplane, the new engineer as an organizer of labor and distribution, radio and television. Then "Control," full statured, sums up the significance of the inventions, saying, "I am the engineer. All of nature's forces have been made my constant servants in attendance. I control, I convert. I do not create," with the final statement, the motif of the whole celebration, "What is not yet, may be."

SCIENTIFIC NOTES AND NEWS

THE Duddell Medal of the Physical Society of London for 1930 has been awarded to Dr. A. A. Michelson, of the University of Chicago. This award is made annually to one who has contributed to the advancement of knowledge by the invention or design of scientific instruments or by the discovery of material used in their construction.

THE Cameron Prize of the faculty of medicine of the University of Edinburgh for 1930 has been awarded conjointly to Dr. George R. Minot, physician-in-chief to the Collis P. Huntington Memorial Hospital of Harvard University, and to Dr. William P. Murphy, assistant physician in the Peter Bent Brigham Hospital, for their work on the liver treatment of pernicious anemia.

As a part of the fiftieth anniversary celebrations of the American Society of Mechanical Engineers a luncheon was given at Washington on April 8, at which medals were presented to Dr. C. E. Grunsky, president of the American Engineering Council; Loughman St. L. Penred, editor of *The Engineer*, Great Britain; Brigadier-General C. H. Mitchell, University of Toronto, Canada; Georges Claude, France; Dr. Ing. Conrad Matschoss, Germany; Dr. Masawo Kamo, Tokio Imperial University, Japan; Senator Luigi Luiggi, Italy; Professor Donato Gaminara, Uruguay; Professor Julio Garzon Nieto, Colombia; Hofrat Ing. Ludwig Erhard, Austria; Baron Gaston de Bethune, who received the medal on behalf of seven Belgian engineers; Professor D. Dresden, the Netherlands; Vilhelm F. A. Nordstrom, Sweden; Professor Aurel Stodola, Switzerland; Norberto Dominguez, Mexico; Dr. S. Spacek, Czechoslovakia. The medals were presented by the ambassadors or ministers representing the different countries. Julio Kilenya, portrait sculptor, designed the medal. It symbolizes the engineer and his past and present achievements.

THE Burroughs Medal of the John Burroughs Memorial Association has been awarded to Archibald Rutledge, a writer on nature subjects. Holders of the medal have been William Beebe, Ernest Thompson Seton, John Russell McCarthy and Frank M. Chapman. The award was presented by Dr. Clyde Fisher, president of the association.

DR. C. E. HELLMAYR, associate curator of birds at the Field Museum, Chicago, has been awarded the Megaud d'Aubusson Gold Medal by the Société Nationale d'Acclimatation de France, for his work on South American birds. Recently Dr. Hellmayr was awarded the Brewster Medal by the American Ornithologists' Union.

THE doctorate of laws will be conferred by the University of Edinburgh on Sir William Hardy, director of food investigation, Department of Scientific and Industrial Research; Sir David Wallace, consulting surgeon to the Royal Infirmary, Edinburgh; Professor W. W. Watts, professor of geology, Imperial College of Science, South Kensington, and Professor K. F. Wenckebach, emeritus professor of medicine, University of Vienna.

DR. W. R. BLOOR, biochemist of the University of Rochester, was elected president of the Federation of American Societies for Experimental Biology and reelected president of the American Society of Biological Chemists at the recent meeting in Chicago. Dr. Frederick L. Gates, of the Rockefeller Institute and Harvard University, was chosen president of the American Society of Pathology; Dr. George Wallace, of the Bellevue Hospital, New York, was elected president of the American Society of Pharmacology and Experimental Therapeutics, and Dr. Walter J. Meek, of the University of Wisconsin, was reelected president of the American Physiological Society.

THE retirement after a service of forty years is announced of Dr. William M. Esten, professor of bacteriology at the Connecticut Agricultural College, at Storrs, effective September 1.

DR. RAYMOND C. PARKER, who has been connected with the cancer research organization of the University of Pennsylvania, joined the scientific staff of The Rockefeller Institute for Medical Research on March first.

DR. WILLIAM A. PERLZWEIG, associate in medicine and chemist to the medical clinic in the Johns Hopkins University, has been appointed professor of biochemistry in the Duke University School of Medicine, effective July 1, 1930.

DR. E. L. HILL has been appointed assistant professor of theoretical physics at the University of Minnesota. He will begin his work there in September.

DR. LOUIS EHRENFELD, of Northwestern University, has been appointed curator of organic and industrial chemistry in the Museum of Science and Industry, Chicago; Mr. Herman R. Eberle, of the Michigan College of Mining and Technology, has been appointed assistant curator of mining, and Mr. M. K. Hubbard, of the University of Chicago, has been appointed research associate in geology and geophysics.

DR. H. ROSSBACHER has been made superintendent

of manufacturing development at the Kearny, New Jersey, plant of the Western Electric Company.

M. RENÉ BAILLAUD, associate astronomer of the observatory at Marseilles, has been elected director of the observatory at Besançon to succeed the late M. Lebeuf.

R. E. HELLMUND, chief electrical engineer of the Westinghouse Electric and Manufacturing Company, has been elected a member of the board of directors of the German Institute of Electrical Engineers.

A CONSULTATIVE committee on cancer research, consisting of representatives of the University of Manchester and of the Manchester Committee on Cancer, has been established. The research work will be conducted in the university laboratories, and will be directed by the committee. Mr. C. C. Twort, M.D. (Aberdeen), who has been working under the direction of the Manchester Committee, has been appointed director of the department of cancer research.

THE Board of Conservation and Natural Resources of the State of Illinois has asked a committee consisting of William Trelease, H. C. Cowles, C. M. Thompson and M. F. Walsh to recommend some one for appointment as chief of the Natural History Survey, the position held by the late Professor Stephen A. Forbes. Information about suitable candidates may be sent to any member of the committee.

DR. W. J. HOLLAND, director emeritus of the Carnegie Museum, Pittsburgh, has left for Mexico City to set up the ninth replica of diplodocus, first uncovered by a Carnegie Museum expedition thirty years ago.

DR. REMINGTON KELLOGG, assistant curator, division of mammals of the U. S. National Museum, sailed for Europe on March 24. He will spend two or three months in an examination of the fossil cetacean types in various European museums.

MR. M. W. STIRLING, chief of the Bureau of American Ethnology, has returned to Washington from Florida, where he excavated a large shell mound and a sand burial mound near Safety Harbor. A large amount of skeletal material was obtained, as well as a good collection of objects representative of the culture of the period.

MR. N. N. KUSNETZOV-UGAMSKI, of Tashkent, Usbekistan, known for his studies of Hymenoptera, has moved to Samarkand, where he is working in the Research Institute of Meteorology and Hydrology. For the time being, his entomological studies have been discontinued.

DR. H. U. SVERDRUP, professor at the Geophysical Institute of Bergen Museum, Norway, and research associate of the Carnegie Institution of Washington, arrived in Washington on March 1 to spend five or six months there assisting the Department of Terrestrial Magnetism of the Carnegie Institution in the revisions and interpretations of the oceanographic data obtained during Cruise VII of *The Carnegie*. On April 8 Dr. Sverdrup will deliver an illustrated lecture at the Carnegie Institution of Washington on "Some Aspects of Oceanography."

DR. E. G. CONKLIN, professor of biology at Princeton University, delivered a lecture on March 29 before the Royal Canadian Institute, on "Some Present Problems of Evolution."

DR. HENRY B. WARD, professor of zoology at the University of Illinois, gave one of the De Lamar lectures at the School of Hygiene and Public Health of the Johns Hopkins University on April 1. The title of this lecture was "The Introduction and Spread of the Fish Tapeworm, *Diphyllobothrium latum*, in the United States."

DR. WINTHROP J. V. OSTERHOUT, member of the Rockefeller Institute for Medical Research, New York City, will deliver the seventh Harvey Society Lecture at the New York Academy of Medicine, on Thursday evening, April 17. His subject will be "Electrical Phenomena in the Living Cell."

ON March 29, Dr. Edgar L. Hewett, of Santa Fé, New Mexico, lectured at Chapelle House, Denver, Colorado, on the Indians of the Southwest, with special reference to the ruins of ancient pueblos.

DR. GEORGE B. CRESSEY, professor of geology and geography at Shanghai College, China, gave a series of five lectures on the geography of China at Clark University commencing on March 31. Dr. Cressey is spending his sabbatical year as research associate at Harvard University and instructor at Clark University.

DR. WILLIAM MANSFIELD CLARK, professor of biological chemistry at the Johns Hopkins Medical School, gave at the Harvard Medical School on April 1 and 2 the Cutter Lecture on Preventive Medicine. The subject of his lecture, which was given in two parts, was "Reversible Oxidation-Reduction in Organic Systems."

DR. J. FRENKEL, professor of theoretical physics at the Polytechnical Institute at Leningrad, will lecture on "Wave Mechanics" at the University of Minnesota during the academic year 1930–31. He will also conduct a seminar on problems in modern physics.

ON the occasion of the fiftieth anniversary of the foundation of the Ophthalmological Society of the

United Kingdom, on April 3, the Bowman Lecture was given by Sir Arthur Keith. The lecture was entitled "The Genius of William Bowman."

The American Geophysical Union will hold its eleventh annual meeting on May 1 and 2 at the National Academy-Research Council Building, Washington, D. C. The sections of geodesy and meteorology will meet on the morning of May 1 and the sections of oceanography and volcanology in the afternoon. The sections of terrestrial magnetism and electricity and of seismology will meet on the morning of May 2 and the general assembly of the union will be held in the afternoon. The section meetings will be preceded by short business sessions and will include reports on national, international or cooperative progress, as well as scientific papers in each field, except in the case of the section of seismology, the meeting of which will be for business purposes only, as a joint meeting for the presentation of scientific papers is planned with the eastern section of the Seismological Society of America at Washington on May 5 and 6. Following the business session of the general assembly to consider reports of officers, there will be a scientific session on "The Utility of Geophysics" consisting of a series of six papers, one from each section of the union.

The eleventh International Congress of Zoologists will be held at Padua from September 4 to 11, under the presidency of Professor Paolo Enriques. Excursions after the meeting to the valleys of Comacchio, Ferrara, Bologna and Ravenna are planned.

Construction on the new building in Cambridge for the Biological Institute of Harvard University will begin shortly. Plans have not yet been completed, but the Boston *Evening Transcript* states that it is expected that the building will contain no lecture halls, as those in the University Museum fulfil present needs. Instead, it will be devoted to laboratories, research rooms and administrative offices. The site, which has been definitely picked out, is the plot of ground across Divinity Avenue from the museum, a little to the east of Divinity Hall and the Semitic Museum.

Teachers College, Columbia University, receives $500,000 by the will of the late V. Everit Macy.

The Medical School of Washington University, St. Louis, has received from E. Arthur and Frank E. Ball, manufacturers, of Muncie, Indiana, a gift of $60,000 for research in hearing at the Oscar Johnson Institute.

According to a press dispatch, the House of Representatives has voted to create a Textile Foundation to spend and administer a fund of about $2,000,000 for scientific and economic research in the textile and allied industries. The bill provides that the Textile Alliance, a corporation formed immediately after the war to protect the American textile industry in the purchases of dyes, should pay to the new foundation about $2,000,000, which it was supposed to turn over to the government. Under the terms of the charter of of Textile Alliance, it was supposed to make no profits, but through its dealings immediately following the war, to prevent a demoralization of the dye market, it actually came out more than $2,000,000 to the good. The bill provides for a board of directors of the foundation, to be composed of the Secretary of Commerce, the Secretary of Agriculture and three individuals familiar with the textile industry, to be appointed by the President for terms of two, three and four years. The bill gives the directors wide powers in administering the fund, with the provision that an annual report be made to Congress.

The new Institute for Cancer Research was opened at Villejuif, near Paris, on March 17, by M. Doumergue, President of the Republic. He was accompanied by M. Marraud, Minister of Public Instruction, and M. Desiré Ferry, Minister of Public Health. After the opening ceremony the President laid the foundation stone of the new hospital which is to be erected beside the institute. In an address on the work of the institution, M. Ferry said that the importance of a close liaison between the laboratory and the hospital could hardly be overestimated. To the sufferers in hospital would come all the relief that lay in the power of the research worker, who in his turn would be helped to fresh achievement by their practical observations of the progress of the disease. The International Congress on Cancer opened at the new institute on March 18.

The Royal Institute of Public Health, London, has been called on to give up its present site in Russell Square. The lease extends over several more years, but the site is required for the University of London, and the London County Council has served notice that in order that road widening may be carried out the demolition of the institute building is required. After an extensive search of the surrounding district by Sir William Smith, the principal, the institute has acquired a site a short distance away, on which new buildings will be erected. The site acquired is one of the few remaining open spaces in London available for building purposes. It is the plot of land on the north side of Queen Square, with frontages to the square and to Guilford Street. The institute was founded in 1886, incorporated in 1892 and received royal recognition in 1897. Its headquarters were

established in Russell Square in 1905. Here laboratories were constructed for chemical, bacteriological and other research work. The courses of instruction given in these laboratories are recognized as qualifying medical practitioners for admission to the examinations for degrees and diplomas in public health of all the universities and medical corporations in the kingdom.

INDICATIONS of extensive commercial research in Soviet Russia are shown, as reported in the *U. S. Daily*, in large exports from the United States of various types of scientific, laboratory and professional instruments and apparatus in 1929. Soviet Russia became the second most important market for this class of materials last year, being exceeded only by Canada, which is the leading purchaser of American scientific appliances. The shipments to Russia amounted to $400,816, and accounted for a large part of the 23 per cent. gain in the year's exports of these commodities. The total shipments in this group, which is classified as "other scientific, laboratory and professional instruments and apparatus," aggregated $4,344,640 during the year. The materials include scientific instruments for testing physical strength, materials and forces; chemical and physical apparatus, aeronautical, astronomical and bacteriological instruments; graphic recording, military and naval, meteorological appliances; microscopes, laboratory scales, thermometers, barometers, hygrometers, magnets, etc. The exports of these materials showed a gain also during the month of January, when shipments amounted to $344,763, an increase of 13 per cent. over the corresponding month of 1929.

DISCUSSION

A SACRIFICE TO PELE

DOWN along the thinner borders of the lava overflows from Kilauea, which four years ago surged out into the fern forests and cut off some acres of them, where Pele's glowing strands had floated round, I noted last October that many of the tree fern stumps, somewhat pocketed in the light and fluffy lavas from one to three feet thick, seemed again to come to life. Could that be? I asked, and was told it was apparently so.

Then I looked over about an acre of the former fern forest, noting many of the stumps which seemed to send up the gnarled, irregular shoots, rather large for the time in which they had appeared, if grown from spores and prothalli. No soil seemed to have gathered over these shoots; their roots were imbedded deeply in the chaffy tops and remnants of the old stumps. No other plants or ferns of any kind whatever were to be noted round about, although the rough, deeply furrowed lavas should have favored soil forming and the growth of prothalli. Without previous and continued observation of the stumps from the time of the flows and without the digging up of the stumps from beneath the lavas, it seemed necessary to consider the amazing explanation of survival. Not knowing the forms of the fern forest very well, I can't say which of the several species was concerned, or how.

Could a surging, fiery spray of thinning waves of basaltic lava of extreme liquidity, flowing rapidly about the fern trunks with their heavy mat of wet, insulating chaff, perhaps with accompanying torrential rain, cool quickly enough to leave strands of the fern stumps still alive? And then, with initial rootlet cell growth, could a stalk cell form, and life begin anew? This much is certain: the liquid lava temperatures, usually recorded as from 800° to 1,200°, would be nowhere near so high about the fern stumps while the free tops of the forest were cut down. There would also form about the chaffy outer mass a jacket of steam which would hold the lava away from the stems as water from below made its escape. The trunks themselves and the fern forest floor would be further protected by a dust and ash coating precedent to the flow. The lava is very vesicular.

Recently the subject of reforestation following devastating eruptions, especially at Krakatau and at Katmai, has claimed some further attention. It has been found that the destruction of the original flora is not so extreme as earlier supposed. Certainly, ferns do come up from beneath the ash when it is washed away by the rains.

G. R. WIELAND

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BRANCHING HABITS OF THE HEVEA RUBBER TREE

MANY tropical trees have specialized habits of branching, which may be viewed as adaptations to forest conditions. Darwin and many other writers have recognized that forest vegetation in the tropics must meet an intensive competition for space and light. Chances of survival are greater for seedlings or saplings that can outgrow the surrounding vegetation and reach the sunshine. The seedlings of Hevea are specially adapted to undergrowth conditions in tropical forests.

Instead of beginning to branch near the ground, as do the more spreading trees of temperate climates, the specialized tropical species send up at first a tall, slender stalk, with branches only at the top. The

Central American rubber tree (Castilla) forms temporary branches on the lower part of the trunk, different from the permanent branches that appear later. Coffee, cacao and cotton are other examples of plants that have specialized lateral branches, different in structure and function from the uprights. In such cases the branches are said to be of two forms, or dimorphic. Several systems of dimorphic branching are known, though botanical text-books usually treat only of monopodial and sympodial systems, which may or may not be connected with dimorphism. The branch specializations undoubtedly should receive greater attention from morphologists than has yet been given.[1]

In the development of the Hevea tree two distinct growth periods or phases may be recognized, as in the cacao (Theobroma) and the patashte (Tribroma). The juvenile phase covers the growth of the primary upright, while branching signalizes the adult phase. The upright is built of a long succession of internodes whose buds normally remain dormant, though able to replace a lost or damaged terminal bud. The upright develops by flushes or spurts of growth, with each of the growth-sections ending in a close-set cluster or whorl of leaves. Lower internodes of the growth-sections often are four or five inches long, and sometimes six to nine inches, while the internodes that produce the leaves in the terminal clusters are only a quarter or an eighth of an inch in length. The interrupted growth, suppressed buds and pronounced inequality of the internodes are specialized features.

The adult phase of Hevea usually begins with a terminal whorl of branches, though not so definitely specialized as in Theobroma and Tribroma, which have regular numbers of branches in the whorls, five and three respectively. Also in the Ceara rubber tree (*Manihot glaziovii*), a relative of Hevea, the branches are regularly in threes. In Hevea, whorls of three, six and twelve branches occur, as well as intermediate and larger numbers of branches. Even where the branches of Hevea are not definitely clustered, the main stalk loses its predominance. Adult Hevea trees are essentially candelabrum-like, seldom showing any tendency to retain a strong central axis.

The primary upright of Hevea usually attains ten to twelve feet, and often fifteen to twenty feet, before any branches are formed. Some of the trees fork at five or six feet from the ground, especially those that have been cut back or injured, while others form several whorls of abortive branches before the permanent branches develop. Under forest conditions, branches that do not have upright or ascending positions are not likely to be permanent, but are overshadowed and die. Border trees may develop rather large horizontal branches, but these become topheavy, twisted and diseased. The normal habit of the species is shown by the slender, few-branched forest trees, rather than by the more spreading open-grown trees.

Propagation of Hevea from cuttings was reported by several experimenters in the East Indies soon after the first introduction from Brazil, but efforts in recent years to root cuttings from mature trees are reported as complete failures. Readier rooting of cuttings by the first experimenters may be connected with the fact that the lower section of the trunk has the power of producing adventitious roots, and only seedlings were available in the early years. Rooting above the crown has been observed at Chapman Field, in southern Florida, in experiments where the level of the soil has been raised by top-dressing. The root swells in advance of the trunk, and may attain nearly twice the diameter, a few inches below the surface of the soil. The enlargement of the trunk at the base is an important feature as determining the extent of tapping surface accessible from the ground.

Propagation from buds of high-yielding trees has been practiced for several years in the East Indian rubber plantations, but the budded trees are reported to differ generally in having narrow cylindric trunks, not thickened at the base as in the normal trees. This behavior has been ascribed to incompatibility and great variation in the stocks, but may be a consequence of specialization of the branches. The ability to regenerate uprights may be lacking in the lateral branches of Hevea, as in those of Theobroma and Tribroma. The lateral branches of coffee and of the Central American rubber tree also fail to produce uprights, and are not of use for vegetative propagation, although sections of the uprights are readily rooted.

Thus the specialized habits of branching in Hevea may throw light on cultural problems which hitherto have remained obscure. The commercial cultivation of Hevea did not begin till 1896 and has been confined largely to the East Indies. Recently it has been learned that Hevea can grow in southern Florida and is more tolerant of cold than many other tropical types. A Hevea tree has survived for nearly thirty years in an open-air planting at Palm Beach, and is still vigorous and healthy, though of small size.

O. F. COOK

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[1] "Dimorphic Branches in Tropical Crop Plants: Cotton, Coffee, Cacao, the Central American Rubber Tree and the Banana," U. S. Department of Agriculture, B. P. I. Bulletin 198, 1911. "Branching and Flowering Habits of Cacao and Patashte," Contributions from the U. S. National Herbarium, Vol. 17, Part 8, 1916.

WHAT IS CONTROL?

THE application of insecticides is now called control by the vast majority of entomologists, as is that of fungicides by practically all mycologists. Formerly the medical terms, remedy, treatment and preventive, prevailed. The writer has checked over more than a hundred of the most recent Experiment Station bulletins on insects and fungi and finds less than 5 per cent. of the writers using the latter terms in the place of the term control.

The reason for the change was perhaps a reaction against the idea that remedies are, or should be, effective as eradicative measures. It became very evident that what could be accomplished was not a cure of the trouble, but only sufficient mitigation to make it possible to obtain a satisfactory crop, so the term control was introduced and has finally practically displaced the older terms.

In a few of these publications, the term control is made to include the action of parasites and predators, just as in the days of Riley they were spoken of as natural remedies, as contrasted with artificial remedies.

The term control carries the thought of definite conscious action of a rational being, something done by man for his own benefit. It may be indirect through a mechanism he has set up, but it is always something that carries out his will. According to the older thinking, certain actions of nature were also conceived as controlled by an intelligence who ordered everything for the benefit of man and of individual men, and thus we had natural remedies administered by this higher power who used parasites and predators as his agents. Either the retention of this conception of nature, or more likely, the unthinking retention of this form of statement gives us now natural control.

Contrasted with this is the use of the word uncontrolled, which is almost universally expressive of the action of nature where a control by man is not exercised. Natural control is thus a contradiction of terms, because it is equivalent to non-control, and should disappear from the literature of entomology.

C. W. WOODWORTH

OESTRUS FOLLOWING THE REMOVAL OF ONE OVARY

IN a recent number of SCIENCE[1] it was pointed out by Nelson that a pregnant rat had copulated several times during the gestation period and that young were born and suckled. After the lactation period oestrus again occurred but subsequent matings were infertile. These observations are interesting not only from the standpoint of oestrus during pregnancy but also because in this case one ovary had been previously removed. It is well known[2] that the removal of one ovary results in the so-called hypertrophy of the remaining ovary with the formation of many large follicles. These changes may be accompanied by disturbances in the various phases of reproduction.

During the past year the writer has studied more than a hundred rats with respect to oestrus before and after semioophorectomy. It was found that the oestrus cycle was slightly shorter during the first few weeks following the removal of one ovary and that the usual cornified cell stage representing the heat period occurred at quite regular intervals. After two months the remaining ovary had considerably increased in size and the cornified cells in the vaginal smears occurred more frequently. The number of these cells and the frequency of their occurrence were variable. Some animals had normal cycles, while others were in heat most of the time. Indeed, with a few rats one could not tell with certainty when one cycle ended and another began.

TABLE I

FREQUENCY DISTRIBUTION FOR LENGTH OF THE OESTRUS CYCLE OF FIFTY RATS. A, BEFORE OPERATION; B, AFTER REMOVING ONE OVARY

Length in days	No. of cycles		Total days involved	
	A.	B.	A.	B.
2	0	34	0	68
3	6	71	18	213
4	116	256	464	1024
5	314	249	1570	1245
6	117	97	702	582
7	22	23	154	161
8	11	11	88	88
9	3	1	27	9
10	1	1	10	10
11	0	2	0	22
12	0	2	0	24
13	1	2	13	26
14	0	1	0	14
Total	591	750	3046	3486
Mean			5.15	4.65
Probable error			± .0272	± .0344

As shown in Table I the average oestrus cycle of fifty rats after the removal of one ovary was significantly shorter than the normal period. The mean difference in this case was 0.50 days, a figure more than ten times the probable error of the difference, which is ± 0.044. These figures, although indicating

[1] W. O. Nelson, SCIENCE, 70: 453, November 8, 1929.

[2] C. G. Hartman, *Am. Jour. Anat.*, 35: 1, March, 1925.

a shorter oestrus cycle in the rats after operation, are not entirely without fallacy. As mentioned above, it often is difficult to determine the duration of any one cycle because of the large number of scales present daily in the vaginal smears; irregular cycles may also occur in apparently normal animals.

The rats considered in Table I were observed daily during a period of four months before operation and during a similar period after operation. It would seem unlikely, therefore, that these changes are incidental. Other experiments now under way confirm the results shown in Table I.

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A NEW RECORD OF CASTOROIDES OHIOENSIS FROM ILLINOIS

A perfect skull of the giant beaver, *Castoroides ohioensis* Forster, has been sent to the Museum of Natural History of the University of Illinois for identification. It was found in a gravel pit on the farm of Mr. W. A. Paullin, near Bellflower, McLean County. While the details of the find are not very clear as regards stratigraphic relationships, it is evident from the perfect condition of the skull and also from the presence of clay in the brain cavity and in other parts of the skull, containing fresh-water mollusk shells, that the skull lay at the base of the gravel which was outwash from the Champaign moraine, covering the Shelbyville till sheet which underlies the Champaign till sheet in this region. That the specimen was originally buried in a lake or other body of water is clearly evidenced by the diverse character of the molluscan fauna found in the clay, which included the following species.

Sphaerium sulcatum	*Pomatiopsis scalaris*
Pisidium species	*Helisoma antrosa striata*
Valvata tricarinata	*Gyraulus altissimus*
Amnicola leightoni, var.	*Gyraulus urbanensis*
Cincinnatia cincinnatiensis	*Ferrissia paralella*
Pyrgulopsis species	

The stratigraphic horizon of the deposit in which the skull was found is Early Wisconsin, substage 1 of Leverett, or the earliest division of the Wisconsin stage of the Pleistocene. *Castoroides ohioensis* has been reported from all interglacial intervals of the Pleistocene, from Aftonian to post-Wisconsin, and is known to have lived in pre-Glacial time. Five records[1] are known from Illinois previous to the present specimen; these are: Shawneetown, Gallatin County, teeth fragments, Le Conte, 1852; Charlestown, Cowles County, skull, Leidy, 1869; Naperville, DuPage County, Bannister, 1870; Quincy, Adams County, Worthen, 1870; Alton, Madison County, Worthen, 1890. The animal was evidently wide-spread over Illinois, the records covering the length and breadth of the state.

The Bellflower specimen is being studied by Dr. A. R. Cahn, of the University of Illinois, who will make a detailed report of the specimen.

Frank Collins Baker

University of Illinois

[1] Baker, "Life of the Pleistocene."

PROFESSIONAL ETHICS AND THE ARTIST

Dr. Stiles' article "Absent-mindedness as a Factor in Professional Ethics"[1] brings up a point which scientists may well consider. There is, however, a prologue to the same story which I believe is an even worse ethical abuse than that to which Dr. Stiles calls attention. This is the practice, frequent among scientists of standing, who employ an artist or illustrator to do their illustrations, of denying this artist the right to sign these drawings or illustrations, and in no way making any acknowledgment of the true authorship of these drawings.

The defense is often raised that the artist deserves no credit because he or she is paid to do this work. However, so are scientists usually paid for their work, by government, university or private agency, and yet they invariably claim full credit for all their work (sometimes some of it questionably theirs) by affixing their own signatures. Again it is sometimes advanced that illustrations are very incidental, only a minor feature of a paper—something akin to the services of the stenographer in typing the manuscript. That this theory is also false is clearly shown by the incidents described by Dr. Stiles where illustrations are repeatedly copied by other authors, often without the slightest change. Dr. Stiles objects that in this copying acknowledgment should be made to the original author, the supposed source of the illustration. Why then should not the original author also acknowledge the *real* source of the illustration where it is the work of an artist, and not his own?

It is usually emphasized that these drawings are "made under supervision," as though the artist were merely a machine for mechanically recording the inspiration of the scientist. It is true, of course, that such drawings are made under direction, but the amount of it is in some cases so trivial as to be negligible. Furthermore, many illustrators, after a short novitiate in a particular line, understand what is wanted with only the barest suggestions from the superior, and proceed to solve all the smaller difficulties (and sometimes the larger) by themselves, in the execution of the work. I have personally known of several cases in which the careful, intelligent study of a specimen by the artist revealed details that the

[1] Science, 71: 100–101.

scientist had missed completely in his own shoddy haste. Even cases where the scientist worked from the drawings instead of from the specimens!

My point is that many illustrations for which no credit is given are as truly pieces of research as the manuscript which they are designed to accompany. Perhaps most scientists have the view that the artistic ability required to do a good illustration is really a rather ordinary faculty—something equivalent to learning to run a typewriter—and as such meriting no recognition on a plane with their own lofty genius trained to grapple with the problems of science, like the old gentleman in the operetta who admitted he had never written a sonata, but felt perfectly confident that he could if he ever desired. This delusion is frequent and could be cured by compelling such scientists to do their own illustrations until they could do them as well as their artists.

I believe I may claim to understand both sides of the question, inasmuch as I have studied art as long and as seriously as I have science, and have served an apprenticeship at scientific illustration myself, now discontinued for concentration upon the esoteric and rarified problems of parasitology. And it is my experience that it takes as much brains and training to do an acceptable illustration of a difficult subject as it does to tackle the average scientific problem. Some government bureaus are flagrant offenders in this way, also many workers of prominence in the universities. It is not contended that every diagram, however simple or trivial, should necessarily bear the name of the artist, or receive acknowledgment, but where a piece of writing is accompanied and often greatly enhanced by an elaborate series of illustrations which are not the handiwork of the writer it is plainly dishonest for the scientist tacitly to take credit for this part of the work. If it is not permissible for scientists to filch illustrations from each other it is a "distinction without a difference" that permits them to be filched from the artist. An illustrator's only chance of progress is through recognition of his work. Certainly the most altruistic scientist would object if compelled to publish all his work under the veil of anonymity. Moreover, there is often more real research and honest investigation in the unequivocal lines of a good illustration than there is in many of the padded, purloined and pilfered "contributions" that swell the scientific literature of to-day.

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STATEMENT IN REGARD TO PROFESSOR EINSTEIN'S PUBLICATIONS

BEFORE the time of Faraday and Maxwell, electric forces and magnetic forces were known, but they existed as distinct things, having no apparent relation to each other. To cause magnetic forces to exhibit themselves it was necessary to cause them to act upon magnets, and to cause electric forces to become manifest it was necessary to allow them to attract or repel other charged bodies or attract neutral bodies, but the presence of any magnetic state in those neutral bodies had no apparent effect upon the electrical phenomena. Then, when as the result of the experiments of Oersted, Faraday and others, it was found that a magnet was influenced by an electric current, and an electric current by a magnet, the whole question of the relation between magnetism and electricity became opened up. A composite theory developed in which magnetic and electric forces were intertwined, so that one could not speak in general of the forces upon a moving charge in terms simply of the electric forces, but had to include the magnetic forces as well. Neither could he speak of the forces upon a magnet entirely in terms of what were formerly regarded as magnetic forces, but had to introduce the electric forces as well. Then, for a long time, we had electric forces and magnetic forces harmoniously intertwined, but gravitation standing apart in the same sense as the electric and magnetic forces themselves had stood apart before the days of Faraday and Maxwell. Einstein's new theory as developed a few months ago did the same kind of thing for electric, magnetic and gravitational forces as was formerly done by Maxwell and Faraday for electric and magnetic forces. A composite theory intertwining all three was successfully produced. Just as in the purely electromagnetic problems, there were special cases of the composite structure in which the forces involved were purely electrical, the magnetic ones being negligible, and other cases in which the forces involved were almost purely magnetic, the electric ones being negligible, in such manner as to have suggested originally that these two types of forces were entirely indistinct, so in the composite theory involving magnetism, electricity and gravitation there are certain special cases in which the gravitational aspects are all-important to the exclusion of the electromagnetic, and others in which the electromagnetic aspects are all-important to the exclusion of the gravitational. So far our experimental researches have concerned themselves with cases of this kind, so that it has been our philosophic desire rather than the needs of experiment which has driven us to hope for a correlation of gravitation and electromagnetism in one general scheme.

A complete presentation of any physical theory involves two parts: first, a statement of the general laws governing the phenomena, and second, an application of the laws to some specific problems of interest to us. Thus in the time of Newton, the scientific thought of the day agitated itself concerning the consequences to be expected from the supposition that the heavenly bodies attracted each other with forces which varied as the inverse square of the distances between them. This constituted the general law, but it remained for Newton to show that one of the consequences of this law was that a planet would travel around the sun in an ellipse with the sun at one focus. This constituted the solution of a particular problem based on the general law.

Again when in 1915 Professor Einstein brought out his general theory of relativity some of the most interesting consequences resulted from his success in applying it to the motion of a planet around the sun, to the motion of a beam of light past the sun and to some of the peculiar motions of the heavenly bodies which were not readily understandable in the Newtonian theory.

It now appears that Einstein has succeeded in working out the consequences of his general law of gravity and electromagnetism for two special cases just as Newton succeeded in working out the consequences of his law for several special cases. It is frequently very difficult to solve special problems illustrating the application of a general law, yet the practical value of a law is enhanced in proportion to the extent to which it is capable of being applied to practical problems. When some actual problem arising in a general theory has been solved, we are in a position to formulate experiments on the basis of that problem with a view to testing the general theory underlying it. It is hoped that the present solutions obtained by Einstein, or if not these, then others which may later evolve, will suggest some experiments by which the theory may be tested.

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CONFERENCE AT CHICHEN ITZA

During the third week of January there was held at the archeological field station of the Carnegie Institution of Washington at the ruins of Chichen Itza an informal conference of persons interested in development of researches bearing upon the history of man in the Yucatan peninsula. The following were present: Sr. Eduardo Martinez Canton, inspector of archeological monuments for the State of Yucatan, representing the Mexican government; Dr. F. M. Gaige, biologist, of the University of Michigan; Dr. Robert Redfield, social anthropologist, of the University of Chicago; Mr. C. L. Hay and Dr. George C. Vaillant, archeologists, of the American Museum of Natural History; Dr. George C. Shattuck, of the Department of Tropical Medicine, School of Public Health, Harvard University; Dr. A. M. Tozzer, chairman of the department of anthropology, Harvard University; Dr. Eyler N. Simpson, of the Institute for Current World Affairs, and Dr. S. G. Morley, Mr. Karl Ruppert, Mr. H. B. Roberts and Dr. A. V. Kidder, archeologists, of the Carnegie Institution.

The purpose of the gathering was to discuss, without agenda and in a purely preliminary way, the desirability of bringing to bear upon the historical problems of the area the resources of various disciplines and to consider methods for the prosecution of cooperative research. It was accepted as a premise that historical evaluation of the archeological facts derived from the excavations of Dr. Morley and his staff would be rendered immeasurably more precise by the accurate knowledge of environmental conditions which could be supplied by specialists in biology, geology, meteorology, etc.; and of information as to human factors, past and present, which could be collected by workers in documentary history, medicine, comparative linguistics and the several social sciences. It was taken for granted that the findings of such non-archeological specialists would not only be of intrinsic value to the sciences represented by them, but that they would gain cumulative importance because geographical concentration would permit pooling of data, interchange of ideas, as well as formulation of combined attack upon problems of common interest. It was felt by the majority of those present that precise statement of objectives and rigid organization would be unwise; that research should be allowed to flow in such channels as the shifting contours of individual investigations might throw open; and that propinquity and the mutual interest stimulated by simultaneous attack upon related problems would lead naturally to a more effective type of cooperation than could, in the present embryonic state of most methodologies, possibly be planned in advance.

The conclusion, therefore, was that all studies should be independent, intensive and highly specialized, and that limited and definite goals within each science should be aimed for. A historical view-point, in the broadest sense (in other words a consciousness of the implications of the time element in the recording and interpretation of phenomena), should, however, be adhered to; and close but informal touch should be maintained among all workers in order that they should keep cognizance of the methods, the general trends and the bearing upon their own fields of each other's activities.

The above more or less theoretical aspects of the

matter having been considered, attention was turned to specific investigations and stock was taken of researches in progress or in contemplation. At present under way are the following: Archeological work at Chichen Itza, under direction of Dr. Morley, now in its seventh year; excavations at Uaxactun, Department of the Peten, Guatemala, under direction of Mr. O. G. Ricketson, Jr., fifth year; heiroglyphic research by Dr. Morley; ceramic survey of the Maya area by Carnegie Institution, being inaugurated during the present year by Mr. Roberts (all the foregoing are projects of Carnegie Institution); medical survey of the Yucatan peninsula by Harvard University and Carnegie Institution, now in its second year; records of Chichen Itza clinic administered by Miss MacKay, third year; biological reconnaissance (1930) by University of Michigan, Dr. Gaige; ethnological reconnaissance (1930) for Carnegie Institution by Dr. Redfield, of the University of Chicago; studies of Maya linguistics at Chichen Itza by University of Chicago, Dr. Andrade (1930).[1]

Proposed activities of the Carnegie Institution are: historical work on the Conquest and the Colonial Period; retranslation and collation of the books of Chilam Balam; investigation in physical anthropology by Department of Genetics; air-survey of Maya area. All the above were discussed, and consideration was given to the relation to various aspects of the project of climatology, geology, sociology, psychology, etc. Advantage was taken of the presence of Messrs. Tozzer, Hay and Vaillant to review in detail the local archeological investigations of the institution, to consider its wider implications and to solicit their advice as to future activities.

A. V. KIDDER

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[1] Summaries of the results of these units of work will appear in the Year Book of the Carnegie Institution in December, 1930.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

LABORATORY AND TEACHING DEVICES MADE FROM PLASTER OF PARIS

OCCASIONS in the teaching and research laboratory often arise when an irregularly shaped vessel or chamber is desired or when one wishes to construct a teaching model which will greatly resemble the original. For this purpose plaster of Paris has long been used. Several decades ago A. Edmunds[1] used it for the construction of kidney and intestinal oncometers. More recently the writer has had occasion to employ it for both teaching and research apparatus.

Some time ago while teaching a general course in hygiene and public health at the summer session of a normal school, the writer discussed the utility and necessity of septic tanks in rural or semi-rural communities. The difficulties in explaining the various features of septic and Imhoff tanks were well-nigh unsurmountable. This led to the idea of constructing small models of these tanks.

Using the proportions given in the standard text and reference books, but greatly reducing the dimensions, foundations were made from wire cloth such as is used in screen doors; the corners were either bound with fine wire or soldered. It was found best to use small wooden strips as stretchers inside of the frame until after the first, external, coat of plaster had hardened. These stretchers were then removed and a coat of plaster was applied to the internal surface of the wire. After this coat had hardened, irregularities were removed by scraping with a knife, rubbing with coarse sandpaper or by the application of a thin mixture of plaster of Paris rubbed down with the fingers. Small brass pipes were used at the points where the inflow and outflow pipes are regularly found.

When constructing Imhoff tanks, it was found best to make the floor and side walls of the settling or upper chamber of glass plates in order to render the interior of the sludge chamber visible. The sludge pipe was made from a piece of $\frac{3}{8}$-inch brass pipe to which was soldered a short length of the same sized pipe at a 15° angle. This latter short piece of pipe was passed through a hole made in the side wall of the model after which repairs to the wall were made with plaster.

Recently during an investigation of the circulation of the liver,[2] the writer found it necessary to construct an air-tight chamber suitable for receiving the livers of cats, dogs and rabbits in their natural position while fluid was being perfused through them. In this case a V-shaped box was made from $\frac{1}{4}$-inch wire netting, the corners soldered, and this box was covered with plaster of Paris in the manner described above. Here, however, the open edge was built up well above the wire frame and nearly an inch wide. When the plaster was well hardened, the box was held in the obverse position and the edges about the open end were ground smooth with sand paper so that a piece of glass would form a closely fitting cover. A beeswax-vaseline mixture of proper melting-point was

[1] A. Edmunds, *Journal of Physiology*, 22: 380, 1898.

[2] A. R. McLaughlin, *Journal of Pharmacology and Experimental Therapeutics*, 34: 147, 1928.

found satisfactory for tightly sealing the cover on the hepatic oncometer and cotton saturated with this mixture was used to seal the openings provided for the inlet and outlet cannulae. The oncometer was rendered impervious to air and water by means of the methods described below.

These models may be rendered air- and waterproof by heating them in an oven or hot air sterilizer until they are thoroughly dried. While still so hot that they must be handled with cloths, melted paraffin is poured into the model. By rotating the model, melted paraffin may be made to permeate all parts of the plaster, thus rendering it air- and water-tight, or it may be painted with spar varnish or brushing lacquer both inside and outside. This varnish treatment is most satisfactory for the models of the septic tanks since they may then be handled without being soiled. Dust may also be removed without leaving the plaster in a smeared condition.

SUMMARY

A method has been described whereby models of septic tanks for teaching public health and oncometers for physiological demonstration and research may be constructed by employing a wire frame and covering it with plaster of Paris.

These models should prove especially useful to teachers in rural and suburban communities and to extension workers whose task it is to keep a vast number of our population informed as to the best measures of protecting their health.

These models may be rendered impervious to air and water by means of paraffin, varnish or brushing lacquer.

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ELIMINATING OPAQUING BY ALTERNATING BLACK AND WHITE BACKGROUNDS WHILE MAKING A PHOTOGRAPH[1]

PHOTOGRAPHS of most biological subjects are more pleasing if the finished print has a white background. Such backgrounds are ordinarily secured by placing a piece of white cardboard or an illuminated groundglass behind the object to be photographed. Unsatisfactory ones are often "blocked out" with some opaquing material, but this procedure is always tedious and, in the case of some biological subjects, impossible. Unfortunately many subjects whose print value would be enhanced by a white background refuse to yield satisfactory negatives when photographed against white backgrounds. Thus, such subjects as yellow, hairy, dark-spotted caterpillars, or sections through diseased potatoes, when photographed against a piece of black cloth yield negatives that present the object with excellent detail and gradation, but the resulting picture (print) will have a drab tone because of the black background. The loss of detail when using a white background is accountable chiefly to the great difference in exposure required by the background as compared with the object itself. Obviously it requires far less time to photograph a piece of white paper than a dark object. The white background literally overexposes a large portion of the negative as a result of the additional time required to record the object itself. Hence the white background induces sufficient halation and "fog" to obscure both the detail and color value of the outer portion of the object.

The writer's method for avoiding this difficulty consists in using a black background (black cloth) during most of the exposure, but towards the end of the time required by the object itself, inserting a piece of white cardboard so that a white background will result in the finished print. By experience it has been determined that for ordinary lighting conditions a pure white background is insured by inserting a white cardboard as background for not more than one third the total time required by the object. At first both backgrounds were used in the same plane, but after several trials better results were obtained by placing the white cardboard closer to the object and keeping it in position for only one fourth the total exposure required. This method almost entirely eliminates halation and records the desirable qualities in the negative which one expects from a black background, but insures a white background in the finished print.

The technique for carrying out the black-white background procedure is very simple. The object to be photographed is placed on a piece of plate glass mounted conveniently beneath the camera. A piece of black velvet photographic cloth is stretched at a distance of about six inches beneath the object on the glass, and the camera is then stopped down so that the exposure for the object itself will require at least twenty seconds. A large square of cardboard is held in readiness for insertion during exposure. First the shutter is opened and the negative exposed for from two thirds to four fifths the required time; then, at the end of this period, the white cardboard is put in position about two inches beneath the glass and, at the end of the total exposure, the shutter is closed. For example, if twenty-five seconds is required for optimum exposure of the object, the first seventeen seconds should be with black cloth only, and the last eight with the white cardboard inserted. For large objects, such as a potted plant, the same

[1] This method was developed at the Virginia Truck Experiment Station, Norfolk, Virginia.

effect may be obtained by hanging a white cardboard on a wire so that it may be drawn back and forth as needed.

Occasional subjects require a gray background. Any shade of gray may be obtained by varying the time for white and black. Obviously the longer the time with black, the shorter with white, the darker the background produced.

This method will eliminate the tedium of opaquing and blocking out of negative where black backgrounds have been found desirable in making the negative but undesirable in the print.

The writer intends to use a modification of the method for making photomicrographs. For this purpose it will be necessary to prepare a substage, the illumination of which may be alternated by white and black disks such as are provided on binocular microscopes.

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SPECIAL ARTICLES

COMPONENTS OF AIR IN RELATION TO ANIMAL LIFE

OXYGEN, since the time of Lavoisier, has been considered the vital component of the air. The 79 per cent. inert part has had little use assigned to it. Popular opinion had stated that animal life would be more efficient if these inert gases were replaced by oxygen.

Carefully conducted experiments, covering a period of eight years, have been carried out by the writer and his assistants.

A glass jar of five-gallon capacity was used as an air-tight container for the larger animals and a gallon bottle for the smaller ones. The gas was introduced through holes in a stopper fitting the larger mouth of the container, entering at the top and passing out near the bottom. The natural feed for the different animals and water were kept before them constantly. A small container of sodium hydroxide was placed at the bottom of the jar to take up any excess of carbon dioxide. The outflow of gas from the glass jar was passed through lime water to show that carbon dioxide was given off and the speed of the escaping gas.

The gas in the jar was frequently tested quantitatively, and the analysis showed that it never had an excess of carbon dioxide over that of ordinary atmosphere. A very accurate record was kept of the rate of breathing and the general appearance of the animals. Chemically pure oxygen was used.

Animals can not live in an atmosphere alone of oxygen, nitrogen, carbon dioxide, helium or argon. In a series of thirty experiments it was found that small animals such as mice, rats, pigeons, cats, guinea-pigs, snakes, monkeys, etc., can live in a medium of air under control, but in pure oxygen under the same conditions they will die within from two to five days. In only one case did any of the animals live over a week in oxygen—the snake lived four weeks—while in a current of air we had the different animals under control from one to three weeks without any signs of ailments. With the representative varieties of animal life it was found that in an atmosphere of pure oxygen, with other conditions normal, without a single exception every one would die in oxygen and none in air.

The breathing of the animals was usually found to increase gradually at first in the oxygen atmosphere, but later they appeared to breathe with more difficulty and more slowly until they died. From the appearance of their actions they did not seem to suffer much from pain.

AUTOPSY SHOWS HEMORRHAGE

An examination made by Dr. G. S. Terry of the lung tissue from a guinea-pig which had died in an atmosphere of pure oxygen showed marked evidence of inflammation and interstitial hemorrhage. Cultures made from the lung tissue showed a heavy infection of *Bacillus coli* associated with a few Staphylococci. The conclusion drawn from the autopsy was that an atmosphere of oxygen would not only rupture the lung tissue but also accelerate the growth of certain micro-organisms.

CARBON DIOXIDE AND OXYGEN

Animals were placed in an atmosphere of 99.97 per cent. oxygen and the normal .03 per cent. of carbon dioxide by volume. The animals used for these experiments were guinea-pigs.

With these experiments of carbon dioxide and oxygen the condition of the animals was found to be about the same as with pure oxygen. For this series of four experiments some one was watching them and taking observations day and night.

The general belief that animals could live with the normal amount of carbon dioxide that we have in the atmosphere added to the oxygen tested out to the contrary. Death followed in every case within two to five days as in the oxygen experiments.

THE EFFECT OF PURE OXYGEN UPON WATER ANIMALS

The experiments were continued with water animals in pure oxygen which was passed continuously

through the water. The animals for these experiments were different kinds of fish, tadpoles, snails, newts and water turtles.

Some distilled water was boiled so that the mineral matter and most of the air would be removed to see if there could be any difference from that of tap water. The general results were found to be the same. These water animals tested out just the opposite from the land animals. In this case the pure oxygen could not have had such a burning effect when diluted with water which also soon became saturated with carbon dioxide.

An Atmosphere of Helium and Oxygen

Seventy-nine per cent. helium and 21 per cent. oxygen form an atmosphere under which animal life will exist normally, or in some cases apparently even better. Mice were used for these experiments. Observations were taken every fifteen minutes day and night.

An Atmosphere of Argon and Oxygen

By using argon instead of helium and with the same percentage mixture the animals (mice) would not survive as they did with helium. The argon mixture would diffuse through the living cells less rapidly than the natural air and the helium more rapidly. The density of nitrogen compared to air is .967, that of argon 1.379 and helium .138, which might account for this difference.

By using 87 per cent. argon and 13 per cent. oxygen the mice would live forty-two hours. The respiration of the animals decreased slowly until death but without any apparent suffering. An atmosphere of 80 per cent. argon and 20 per cent. oxygen permitted life for ninety-two hours. Using 75 per cent. argon and 25 per cent. oxygen supported life normally, if not better than normal air, so far as we could observe.

An atmosphere made up of 66 2/3 per cent. argon and 33 1/3 per cent. oxygen supported life but not normally as with a higher per cent. of argon. The mice after six or seven days' confinement in such a mixture would be in poor health. The point of highest efficiency had apparently been passed.

An Atmosphere of Nitrogen and Oxygen

Natural air contains 21 per cent. oxygen, 78 per cent. nitrogen and 1 per cent. mixture of argon, neon, krypton, xenon, helium and carbon dioxide. An atmosphere which contained 21 per cent. of oxygen and 79 per cent. of nitrogen by volume was prepared, leaving out the rare gases. The experiment was repeated six times. Blank tests with normal atmospheres were under simultaneous observation. White mice were used as experimental subjects. No difference in the physiological effects was noted because of insufficient atmosphere supply.

This series of experiments led to the conclusion that the rare air gases such as argon, helium, neon and carbon dioxide are vital for normal respiration. Without these rare gases included with the normal amount of nitrogen and oxygen, life would not exist longer than ten days. The rare gases seem to play a part in normal life equally as important as oxygen.

By increasing the mixture of oxygen to 25 per cent. and decreasing the nitrogen to 75 per cent. the animals were under control for three weeks without any signs of ailment. The experiments were continued by using mixtures as follows: oxygen 30 per cent. and nitrogen 70 per cent.; oxygen 40 per cent. and nitrogen 60 per cent.; oxygen 50 per cent. and nitrogen 50 per cent.; oxygen 60 per cent. and nitrogen 40 per cent., when the animals appeared to be normal and in a few cases better than in the normal air. By making a mixture of oxygen 70 per cent. and nitrogen 30 per cent. they seemed abnormal after being in this atmosphere for about a week. In an atmosphere of 80 per cent. oxygen and 20 per cent. nitrogen they would die in nine days, and they would live but seven days in an atmosphere of 90 per cent. oxygen and 10 per cent. nitrogen.

In an atmosphere of pure nitrogen alone the animals would live but six minutes; in argon alone, three minutes; in pure oxygen, from two to six days, and in hydrogen thirty-seven minutes.

From these experiments with pure oxygen and with the different mixtures of oxygen and other gases it seems that one might be able to find a mathematical curve between the mixture of gases and the time of living with animal life.

In a number of cases it was found that artificial atmospheres could be prepared that supported life in white mice more effectively than the normal air we breathe every day.

In the field of practical applications of prepared atmospheres there is a wide range of commercial uses and values. In deep-sea diving, mines and submarines foul air is encountered and there is often a lack of sufficient amount of air to sustain life. A prepared atmosphere for such activities would broaden their respective ranges of usefulness. An artificial atmosphere in a submarine that sustained life even more effectively than normal air would bring about a safer and more efficient submarine. A prepared atmosphere would be a great advantage to the high altitude fliers.

Medical men have a fair knowledge of the action of oxygen in the air, but little is understood by them concerning the other gases, especially the rare gases.

It is quite possible that a knowledge of atmosphere may aid in the control of diseases. The widest field probably will be in the pathological application.

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SOME CONSTITUENTS OF DERRIS AND "CUBE"[1] ROOTS OTHER THAN ROTENONE

SINCE the introduction of derris root extracts as insecticides, rotenone has been considered mainly responsible for their activity. However, reports from entomologists and others interested in insect control indicate that derris extracts may contain little or no rotenone and still be effective sprays, and also that extracts from which rotenone has been removed as completely as possible are still effective. It may be assumed, then, that such preparations contain materials other than rotenone possessing insecticidal properties. In this connection it is significant that Greshoff,[2] Tattersfield and Roach,[3] Sillevoldt[4] and Durham[5] have isolated various products from derris root, some of which were toxic to fish or insects while others were not. None of these products, however, has been examined chemically.

Recently it has been shown that rotenone is present abundantly in the Peruvian fish poison "cube,"[6] extracts of which are used to some extent as an insecticide in South America. Like derris root, "cube" yields a large quantity of non-crystallizable material, which remains in the rotenone mother liquors.

In the course of a survey of fish-poisoning plants as sources of insecticides which is now being made in this laboratory, the non-crystalline extractives of derris and "cube" roots were studied to determine whether it was possible to obtain any material of definite composition that might be responsible for their physiological action upon fish or insects.

Without entering into details of the methods employed, which will be published elsewhere, it may be stated briefly that, when the non-crystalline material from all samples of derris root thus far investigated was dissolved in methyl or ethyl alcohol and treated with a small quantity of dry sodium carbonate or dilute sodium hydroxide solution, a number of well-defined crystalline compounds were obtained and that invariably three substances predominated. One of these, toxicarol, is a greenish-yellow substance which crystallizes in thin hexagonal plates that melt at 218°–20°. It is a monohydroxy dimethoxy compound, $C_{23}H_{22}O_7$. Another substance, with a pale green color, crystallizes in rodlike plates, having a melting-point of 171°. It is a dimethoxy compound, $C_{23}H_{22}O_6$, and is thus isomeric with rotenone. Recently toxicarol and this second compound have also been found in *Cracca* (*Tephrosia*) *toxicaria*.[7] The third substance crystallizes in short, thick prisms which melt at 198°. It is a dimethoxy compound, $C_{23}H_{22}O_7$, and is possibly tephrosine, which Hanriot obtained from the leaves of *Cracca* (*Tephrosia*) *vogelii*.[8] Although Hanriot reported the melting-point of tephrosine at 187° and assigned to it the formula $C_{31}H_{26}O_{10}$, his preparation was likely impure, consisting in all probability of a mixture of tephrosine and the 171°-melting compound, since the writer found that the leaves of *Cracca* (*Tephrosia*) *vogelii* gave a mixture of these two materials which had a melting-point of about 187°.

Besides the three substances just described a variable number of yellow or orange compounds were found in small quantities in the crude crystalline mixture, but since they are extremely difficult to separate in an analytically pure condition they have not as yet been investigated.

When the rotenone mother liquors from "cube" roots are submitted to the same treatment as described for derris, they also yield a crystalline mixture, which has proved to be either tephrosine (melting-point 198°) and the 171°-melting compound found in derris and cracca or a mixture of these two compounds and a yellow crystalline dimethoxy compound having a melting-point of 217° and the formula $C_{22}H_{20}O_6$.

The yields of these products, both from derris and "cube," are remarkably high. Some specimens of derris, which yielded less than 1 per cent. rotenone, gave by the alkaline treatment as much as 4 to 5.5 per cent. of the crude crystalline mixture, and the samples of "cube" thus far available yielded uniformly about 5.5 per cent. of a 2 to 1 mixture of tephrosine and the 171°-melting compound.

Further work is in progress upon these substances, but from the analytical data now available it appears that all these compounds, including rotenone, are more or less related, and that this small group of chemical compounds may be responsible for the toxic properties of many widely distributed tropical fish-poisoning plants.

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[1] Pronounced coo′ bay. Recently Killip and Smith, *Wash. Acad. Sci.*, 20: 73, 1930, identified the plant as *Lonchocarpus nicou* (Aubl.) D. C.

[2] M. Greshoff, *Pharm. Journ. and Trans.* (3), 21: 559, 1890.

[3] F. Tattersfield and W. A. Roach, *Ann. Appl. Biol.*, 10: 1, 1923.

[4] H. E. Th. Sillevoldt, *Ned. Tijd. Pharm.*, 11: 246, 1899; *Arch. Pharm.*, 237: 595, 1899; *J. Chem. Soc.*, A., 1: 109, 1900.

[5] Durham, reported in footnote 3.

[6] E. P. Clark, SCIENCE, 70: 478–9, November 15, 1929.

[7] E. P. Clark, in press.

[8] M. Hanriot, *Compt. rend. Acad. Sci.*, 144: 150, 1907; *Compt. rend. Soc. Biol.*, 62: 384, 1907.